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## THESIS

A LIFE CYCLE COST STUDY OF  
CONTRACTOR VERSUS ORGANIC SUPPORT OF  
AIRCRAFT PROGRAMS

by

John Joseph McMenamin, Jr.

December 1977

Thesis Advisor:

J. D. Buttinger

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A Life Cycle Cost Study of  
Contractor Versus Organic Support of  
Aircraft Programs

by

John Joseph McMenamin, Jr.  
Lieutenant Colonel, United States Marine Corps  
B.S., Auburn University, 1974

Submitted in partial fulfillment of the  
requirements for the degree of

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from the  
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## ABSTRACT

This thesis conducts a cost comparison between contractor and organic support for the CH-53 Aircraft in two major operating cost areas, training and aircraft overhaul. A life cycle cost approach is used and cost differentials are found for the twenty year life expectancy of the CH-53 system. The intent of the study was not to criticize or change the existing system, but rather to provide cost data and planning insight for future aircraft systems.

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## I. INTRODUCTION

### A. GENERAL

This thesis was originally planned to be a complete life cycle cost study of a major, representative aircraft system. The CH-53 was chosen as the subject of the study simply because of its familiarity to the author. The entire system was reviewed in an effort to uncover areas where reduction in life cycle cost was possible. The intent of the study was not to change the existing CH-53 A/D program, but to uncover areas of possible cost savings that could be considered while planning future aircraft systems. The study is not declared to be exact but rather an approximation of costs that existed at the time of data gathering.

All major cost categories were initially reviewed and the original concept of the study was reduced to two major cost areas, maintenance training and aircraft overhaul. The reasons for this reduction were that the initial range was too broad and voluminous, that viable alternatives of contractor versus organic support were available for the areas selected, and that detailed cost information existed enabling a comprehensive cost analysis. The alternative used in both areas, maintenance training and aircraft overhaul, is contractor furnished support, that is, the aircraft manufacturer, Sikorsky Aircraft.

## B. PRESENT POLICY

The Bureau of the Budget Circular A-76 (Revised) Transmittal Memorandum No. 2 of October 18, 1976 reflects the present policies of the Federal Government concerning commercial or industrial products and services for Government use.<sup>1</sup> It reads:

Background. OMB Circular A-76 expresses the Government's general policy of relying upon the private enterprise system to supply its needs for products and services, in preference to engaging in commercial or industrial activity. This policy reflects the fundamental concept that the government should generally perform only those functions which are governmental in nature and should utilize the competitive incentives of the private enterprise system to provide the products and services which are necessary to support governmental functions. Those commercial or industrial activities which the Government performs directly for itself are not inherently governmental functions, but rather are exceptions to the fundamental concept and their performance by Government personnel must be justified as being in the National interest.

Supplemental Guidance. OMB Circular A-76 sets forth specific circumstances under which it may be in the National interest for the Government to provide directly some products and services for its own use. One of these circumstances permits justification of Government commercial or industrial activity if a detailed comparative cost analysis demonstrates that Government performance would result in sufficient savings to justify involvement in such activity. However, the Circular does not require that a cost study be made in every case to support a decision in compliance with the policy preference for reliance on commercial sources.

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<sup>1</sup>Since the Bureau of the Budget has been superseded by the Office of Management and Budget, this publication will be referred to as OMB Circular A-76 throughout the remainder of this paper.

A cost analysis is not needed in circumstances where the Government's economic interests would be protected, such as the existence of a competitive commercial market, unless the agency has some unique economic advantage which would enable it to supply the needed product or service at less than commercial cost. In determining whether a cost study should be undertaken, consideration should be given to the delay and expense involved in a study sufficiently detailed and comprehensive to provide valid results.

The circular goes on to list the conditions under which a Government commercial or industrial activity may be authorized. [Ref. 1, page 2].

- a. Procurement of a product or service from a commercial source would disrupt or materially delay an agency's program.
- b. It is necessary for the Government to conduct a commercial or industrial activity for purpose of combat support or for individual and unit retraining of military personnel or to maintain or strengthen mobilization readiness.
- c. A satisfactory commercial source is not available and cannot be developed in time to provide a product or service when it is needed.
- d. The product or service is available from another Federal Agency.
- e. Procurement of the product or service from a commercial source will result in higher cost to the Government.

In consideration of present Government policy, it would be justified to note at this point that the entire CH-53 program had been planned and implemented prior to the issuance of the original Bureau of the Budget Circular A-76 on March 3, 1966. It should also be re-emphasized that this study is not designed to criticize the existing CH-53 program

but rather to promote cost saving initiatives in future aircraft systems.

The policies set forth in OMB circular A-76 provide new alternatives.

The circular defines new starts as follows:

A "new start" is a newly established Government commercial or industrial activity involving annual costs of production of \$50,000 or more. A reactivation, expansion, modernization or replacement of an activity involving additional capital investment of \$50,000 or more or additional annual costs of production of \$100,000 or more, for purposes of this Circular, are also regarded as "new starts." Consolidating of two or more activities without increasing the overall total amount of products or services provided is not a "new start."

The circular dictates that no executive agency will initiate a "new start" or continue the operation of an existing "Government commercial or industrial activity" except as specifically required by law or as provided in the Circular. It should be noted here that in this study, with its life cycle cost approach and therefore its application only to planning the entire life cycle of future aircraft systems, the continuance of the existing industrial facilities in the present CH-53 system are justified due to the handling of the value of the land and facilities as available for other uses. In a cost analysis of the CH-53 system, as it exists today, these values would be classified as sunk cost and therefore would not be relevant considerations.

Both areas considered in this study exceed the amounts stated above and do not qualify under the five conditions under which a Government commercial or industrial activity may be authorized. To clarify the second condition, combat support, it is felt that with present day



aircraft (C-5 type) it is no longer necessary for overhaul support to be near the battlefield as it was not in Vietnam.

Therefore, the purposes of this study, the two areas of consideration, training and aircraft overhaul, are considered to be areas in which the program manager has the option of planning for contractor support if this alternative proves to be more economically feasible than organic support within the Department of the Navy.

## II. TRAINING

### A. BACKGROUND

Basically the major areas of cost in designing any aircraft system are the cost of the initial aircraft procurement, the cost of spare parts, and the cost of the manpower required to maintain the system. Procurement should be realized as the most complex and the least variable cost per aircraft unit. The procurement system involves negotiated contracts, both fixed price and cost reimbursement types, between the contractor and the involved defense agency and receives the attention of many members of the Departments of Defense and Navy. The overall management of weapon acquisition is the responsibility of three assistant secretaries of the Navy. [Ref. 2, page 71]. The Assistant Secretary for Financial Management (Comptroller) directs cost estimating, budgeting, and cost control activities. The Assistant Secretary for Manpower, Reserve Affairs and Logistics determines procurement policy and quantities of each weapon to be purchased. He also directs contract administration and program management. And the Assistant Secretary for Research and Development directs ongoing research and development programs and the initiation of new programs. Of the three, the Assistant Secretary for Manpower, Reserve Affairs and Logistics has primary responsibility for policies governing contract negotiation and administration throughout the duration of development and production programs.

Assisting in the acquisition of the CH-53 system was the program manager and his staff. [Ref. 2, page 169]. The program manager is responsible for research, development, evaluation, procurement, deployment and effective overall management of the program.

With all this expertise and high level attention from within the Department of the Navy focused on the acquisition process, it should be assumed that the contract cost was fair to both the contractor and the Navy and was not a variable in any cost study. Therefore, the only major variable in the acquisition process was the number of aircraft purchased.

The number of aircraft to be purchased is arrived at by multiplying the number of aircraft planned for each squadron by the number of planned squadrons and adding an attrition factor. The planned number of aircraft per squadron is dependent upon squadron mission and is arrived at by projecting total flight hours necessary to complete that mission by the Chief of Naval Operations utilization factor of flight hours for each individual aircraft each month. In the case of the CH-53, that CNO utilization factor was, at the time of aircraft introduction to the fleet, 35 hours per month per aircraft and this was the number used when planning for spare parts distribution and manning levels for organizational and intermediate levels of maintenance.

Reduction in the number of aircraft acquisitioned, while maintaining mission capability could only be accomplished by one or more of the following:

1. Aircraft Design

A more efficient design of the system could also produce significant savings in operations and maintenance funds in the future. This idea was not researched because it was assumed that the program manager weighed the cost and benefits of further research and development and conducted his program with the optimum investment in that area.

2. Spares Support

Better planning for spare parts procurement and positioning would reduce the hours of aircraft not operationally ready for flight because of shortage of parts thus reducing the number of aircraft necessary for mission support. This area was researched through interviews with representatives of the manufacturer, Sikorsky Aircraft, interviews with representatives of the Aviation Supply Office in Philadelphia, and with representatives of NAVAIR. All involved personnel agreed that parts shortage problems were not the fault of inaccurate models for parts procurement and positioning, but rather the fault of inexperienced and inadequately trained personnel handling and maintaining those parts. All concerned agreed that with more efficient personnel, the spare parts problem would probably have been eliminated, thus training became a factor.

3. Quality and Quantity of Maintenance Personnel

At the time of introduction of the CH-53 to the fleet, the United States Marine Corps used manpower planning factors contained



in OPNAVINST 5311.3G to arrive at squadron manning levels and to construct the Table of Organization for the CH-53 units.

Exact numbers of personnel will not be used in this report in order to avoid classification since the manpower planning factors are classified confidential. However, in order to increase aircraft availability and hence increase the planned hours per aircraft per month, thus reducing total aircraft procurement, a logical area to start would be to decrease aircraft non-operationally ready because of maintenance (decrease maintenance down time). This could be done by increasing numbers of maintenance personnel and was the early argument of maintenance supervisors since squadron manning levels were considerably below the manpower planning factors contained in OPNAVINST 5311.3G. This approach would increase operational and maintenance cost and thus was not the objective of this research. A more logical area to emphasize would be maintenance training and this approach agrees with increasing the efficiency of spare parts handling.

## B. TRAINING OPTIONS AVAILABLE

### 1. Organic Support

The CH-53 was introduced into the operational forces of the Marine Corps late in 1966. At that time all formal training was accomplished by the contractor with some "on the job" training being accomplished at the organizational level as aircraft inventories were being increased. However, all formal training, beyond the initial

training required to form the nucleus of CH-53 maintenance capability, was programmed to be accomplished at Naval Air Maintenance Training Detachments located at Marine Corps Air Station, New River, on the East Coast, and Marine Corps Air Station, Santa Ana, on the West Coast. In order to support this proposed training, two buildings were erected, one on either coast and the U.S. Navy made substantial investments in other training devices. The total costs of these investments are listed in exhibit #1.<sup>2</sup>

#### EXHIBIT #1

##### COST OF PRESENT U.S. NAVY TRAINING PROGRAM

Initial cadre training by Sikorsky Aircraft including preparation of all software and training material.	\$ 250,000
U.S. Navy instructor training material preparation and training courses.	80,000
Maintenance Trainer design and fabrication for the CH-53A NAMTRADET on the West Coast.	6,000,000
CH-53D Maintenance Trainers for the East Coast.	4,500,000
Construction of West Coast NAMTRADET building.	544,468
Construction of East Coast NAMTRADET building.	544,468 <sup>3</sup>
TOTAL	<u>\$11,918,936</u>

---

<sup>2</sup> All training aids were contractor supplied and the costs listed on exhibit #1 were supplied by Sikorsky Aircraft.

<sup>3</sup> The cost of the West Coast NAMTRADET building was given by the Public Works Center at MCAS El Toro. The cost of the East Coast building has proven elusive, therefore, for the purpose of this report the same figure as the West Coast is used.

All costs listed in exhibit #1 are expressed in terms of 1966 dollars and their total represents the capital investment made by the U.S. Navy into formal training for the CH-53 program. Using a 10% rate of discount which is the current rate directed by Department of Defense Instruction 7041.3, the opportunities foregone in the private sector are valued at \$1,191,894 (10% multiplied by the total costs of \$11,918,936). This amount represents the annual cost to the private sector of the capital investment required to support organic training in the CH-53 program.

In addition to the annual cost of supporting the initial investment required for organic training, operation and maintenance cost also must be considered. Only cost data for the fiscal year 1976 was available during research and this data is quoted in exhibit #2 below. [Ref. 6]. The data includes costs allocated for headquarters support of the Naval Air Training Center at NAS Memphis. This approach is considered proper because in planning future systems some marginal cost for increased headquarters support would be involved if organic rather than contractor support was chosen for training of maintenance personnel.

For the purposes of this analysis, the student salaries of \$422,166 will be omitted since this cost must be absorbed under either organic or contractor training.

In exhibit #2, the contractor category includes outside contracts such as janitorial services. Host pertains to base support activities.



**EXHIBIT #2\***

**CH-53 MAINTENANCE TRAINING**

**TOTAL COST FY76**

**NAMTRA GR DET #1032**

	MILITARY HOURS	CIVILIAN HOURS	MILITARY LABOR	CIVILIAN LABOR	SUPPORT	CONTRACTED	MISC	TOTAL
DIRECT	90051	2453	290156	13100	4516	664	9307	317743
HOST			33868				94271	108139
HEADQUARTER SUPPORT COST			174			8042	27	8243
CNTECHTRA			2338	1619	89	112	222	4380
HOSPITAL			9404			9437		18841
FAMILY HOUSING						4570		4570
STAFF PCS			8557					8557
STUDENT HOSPITAL DEPRECIATION			13467			13467	1064174	1091108
STUDENT SALARY			422166					422166
<b>TOTALS</b>	<b>90051</b>	<b>2453</b>	<b>780130</b>	<b>14719</b>	<b>4605</b>	<b>36292</b>	<b>1148001</b>	<b>1983747</b>

\*The Costs listed on exhibit #2 were supplied by the Comptroller of the Naval Air Training Center in a letter dated 22 July 1977.



Also excluded from this analysis is the \$1,091,108 allocated to student hospitalization/depreciation. This cost is not considered differential cost for the purpose of comparison.

Therefore, a net annual cost of operating and maintaining the CH-53 Naval Air Training Detachment for the fiscal year 1976 was \$470,473. Combining this figure with the \$1,191,894 opportunity cost derived above, the total annual cost of conducting organic training for the CH-53 program for the fiscal year 1976 was \$1,662,367.

## 2. Contractor Support

Sikorsky Aircraft has been interested in receiving a contract to provide all training for the CH-53 program since the early days of the program. Their current cost proposals are listed in exhibit #3. [Ref. 4].

### EXHIBIT #3

#### SIKORSKY COST PROPOSALS FOR CONTRACTORS

##### FURNISHED MAINTENANCE TRAINING FOR THE CH-53 PROGRAM

Preparation of software (not to military specification) Fleet Training	\$ 60,000.
Instructor training materials	35,000.
Training devices	1,000,000.
Expansion of Sikorsky Facilities	175,000.
TOTAL	<u>\$1,270,000.</u>

As can be determined from exhibit #3, an initial capital investment of \$1,270,000 was all that was required by Sikorsky Aircraft

in their proposals to supply contractor training. In order to insure consistency, a 10% discount rate will be used here also, resulting in an annual cost to the public sector of \$127,000 per year.

In addition to this cost, Sikorsky Aircraft proposed a team of 8 instructors at an annual cost of \$30,000 per instructor per year for a total instructor fee of \$240,000. This would result in a total per annum cost to the U.S. Navy of \$367,000 to support maintenance training in the CH-53.

In the Sikorsky proposals, fewer training devices would have been required and would not have had to be to military specifications.

Use of bailed aircraft would have been incorporated into courses to be used as training aids.

Also, the second set of training devices would not have been required due to training being conducted at a single site.

#### C. COST COMPARISON BETWEEN ORGANIC AND CONTRACTOR TRAINING

Using the two annual figures for providing maintenance training for the CH-53 program, a cost comparison over the life cycle of the program becomes possible. Exhibit #4 depicts this comparison and shows that over the 20 years expected life of the CH-53 program, organic training exceeds contractor training by \$11,028,755 in terms of the present value of 1976 dollars. (1976 costs were used as the annual training cost).

# EXHIBIT #4

## COMPUTATION OF LIFE CYCLE COST OF MAINTENANCE

### TRAINING FOR THE CH-53 PROGRAM

	<u>ORGANIC</u>	<u>CONTRACTOR</u>
INITIAL CAPITAL INVESTMENT	11,918,936	1,270,000
times 10% discount rate	.10	.10
sub total	1,191,894	127,000
plus annual operating cost	470,473	240,000
TOTAL ANNUAL COST	<u>1,662,367</u>	<u>367,000</u>
Difference organic less contractors	1,295,367	
multiplied by the annuity factor for 20 years at 10%	8.514	
difference for life cycle	<u>11,028,755</u>	

The lower life cycle cost for training by the contractor absorbs the following:

1. Maintenance and repair of training devices would be considerably less because fewer would have been purchased.
2. Due to training aid and training devices not being produced according to military specification and fewer training devices having been built, a very substantial savings in updating costs would be realized.

#### D. OTHER COST CONSIDERATIONS

Other cost factors exist which are very hard to quantify but nevertheless should be considered in any future decision concerning life cycle cost of planned systems. A few pertinent areas, as they apply to the CH-53 program are listed.

## 1. Travel

An early argument against contractor training was personnel travel expenses. The early plans, as discussed previously, provided for a training site on each coast, thereby keeping travel to a minimum. The cost of travel under the contractor support plan was thought to be excessive since half of the CH-53 squadrons situated within the continental United States were West Coast squadrons. This was a legitimate argument but was never quantified. In addition, the East Coast training site never materialized. All NAMTRADET training for the CH-53 program is performed on the West Coast at Marine Corps Air Station, Santa Ana. As of the date of this writing all initial trainees leave Memphis and are ordered temporarily to either MCAS New River or MCAS Santa Ana. All trainees receive their formal instruction at Santa Ana and then receive their permanent change of station orders which could be to the opposite coast from where they were temporarily ordered for training. This system is by no means the least economical system when travel expenses are considered. Under contractor support, all trainees could receive their permanent orders after Memphis and travel on temporary orders to Sikorsky Aircraft for their formal training. This would eliminate criss-crossing the country under the present system and would also promote morale among the trainees.

## 2. Lodging

Another argument against contractor training was that there are no government quarters available at Sikorsky Aircraft. This is a



legitimate argument when only the first five enlisted ranks are considered, but beyond that, there are no government quarters at Santa Ana available for staff non-commissioned officers or officers. So, this argument loses some of its meaning.

With the numbers of people involved in training for the CH-53 program, an appealing solution would be to provide some sort of government quarters at the factory. No quantifiable evidence is available but a solution may be for the Navy Department to lease an entire apartment complex to provide government housing as some local governments do to provide low-cost housing under the welfare program. An in-depth study would be the subject of another paper.

### 3. Effectiveness

The above cost comparison between contractor and organic training dealt with the efficiency of the existing program, that is, reducing the input dollars assuming a constant output. However, several considerations may alter this assumption.

a. Contractor furnished instructors would be career teaching professionals while organic instructors are aircraft maintenance personnel who have had some instruction training usually from the contractor.

b. The continuity associated with contractor furnished instructors would increase the output thereby increasing the effectiveness of the trainees. Organic instructors usually rotate every three years.

c. Contractor furnished instructors are closer to the source, that is, the aircraft manufacturer, and therefore have a valuable information source readily available.

d. Any changes in systems would be introduced more rapidly to the training factory personnel.

e. In the past, there have been a lack of quotas at the NAM-TRADET. This concern would not exist under contractor training support.

The idea of effectiveness relates back to the concept of a decreased aircraft buy. If personnel are more effective, thereby decreasing the number of aircraft and spare parts necessary to complete the units' mission, then the reduction in life cycle cost would be then reflected in the reduction of the number of aircraft and spare parts acquisitioned. An accurate dollar amount would be hard to identify but in the case of the CH-53, each unit acquisitioned averaged more than \$2,000,000, so considerable savings are possible in this area.

#### E. A COMPARATIVE PROGRAM

Cost studies can be made with a comparative program. Sikorsky Aircraft's Product Support Training was the sole source training for helicopters for the U.S. Coast Guard from 1962 until recently. Sikorsky still teaches all U.S.C.G. helicopter maintenance courses except one. The training presented by Sikorsky Aircraft helps to

enable the U.S. Coast Guard to support approximately 135 helicopters at bases all over the world. The maximum cost of training to the U.S. Coast Guard, in any calendar year, was \$112,000. [Ref. 4].

### III. DEPOT LEVEL MAINTENANCE

#### A. BACKGROUND

At present the various Naval Air Rework Facilities (NARF's) are responsible for the vast majority of all depot level maintenance performed on United States Naval aircraft. This responsibility is assigned by OPNAVINST 4790.20, dated 20 September 1976, which reads:

Depot Maintenance. That rework maintenance performed on material requiring major overhaul or a complete rebuilding of parts, assemblies, subassemblies and end testing, and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing engineering assistance and performing that maintenance beyond the capability of the lower level activities. It provides stocks of serviceable equipment by using more extensive facilities for repair than lower level maintenance activities. These functions may be grouped as follows:

- (1) Standard depot level maintenance of aircraft and engines.
- (2) Overhaul and repair of engines/components, and aviation support equipment.
- (3) Calibrations of equipage.
- (4) Incorporation of designed technical directives.
- (5) Modification of aircraft, engines, and related equipment.
- (6) Manufacture/modification of designated parts/kits.
- (7) Technical and engineering assistance field teams.



Naval Air Rework Facilities' responsibility for all depot level maintenance is firmly entrenched in the Navy's system of operation and dates back to the era when Naval Aviation needed depot level support at the battlefield. This battlefield support was only available through an organic organization. With modern transport aircraft and other means of transportation, it is questionable if this rationale is still valid. For example, no depot level maintenance was performed in Vietnam during that confrontation. Other alternatives should be pursued in an effort to ascertain if a more reasonable, economic alternative is available. This chapter compares proposed contractor overhaul support with organic support in the CH-53 aircraft system.

Although all the functions of a Naval Air Rework Facility, which are listed above, could be included in a comprehensive cost analysis, only those functions concerned with contractor furnished equipment are considered pertinent to this comparison. In the case of the CH-53, the contractor is Sikorsky Aircraft, a division of United Technologies.

#### B. EXISTING RATES

At the time of this writing, almost all depot level maintenance on the CH-53 aircraft was being performed at the Naval Air Rework Facility at NAS North Island. By this statement, it is meant that all complete aircraft overhauls were being performed by NARF, North Island. Some minor component rework was being performed at NARF, Pensacola as a preliminary to moving the entire overhaul of the CH-53

and its components to Pensacola. This move made this comparison possible. In order to allow for the interim period between organic sites, Sikorsky Aircraft has been solicited by the Navy to perform the overhaul during that period, therefore, the cost of contractor support is available. The fiscal year 1977 funded rates for NARF, North Island were obtained from the comptroller division of NARF and are depicted in exhibit #5.

EXHIBIT #5

FISCAL YEAR 1977 FUNDED RATES

FOR

NAVAL AIR REWORK FACILITY, NORTH ISLAND

DIRECT LABOR \$9.76 per direct labor hour

PRODUCTION OVERHEAD

Labor	3.91	
Material	<u>1.16</u>	\$5.07 per direct labor hour

GENERAL AND ADMINISTRATIVE OVERHEAD

Labor	3.30	
Material	.56	
Contract/Other	.36	
Station/Support	<u>3.11</u>	\$7.33 per direct labor hour

TOTAL LABOR AND OVERHEAD \$22.16 per direct labor hour

DIRECT MATERIAL \$28,960.00 per individual aircraft

Direct Labor is computed as the average labor rate. The Production overhead costs include indirect labor, both support and supervisory personnel, and material cost. The latter includes "pre-expended" bin items, i.e., small, standard and inexpensive nut and bolt type items.

The production overhead labor rate also includes lost time and stand-up meetings which are organization meetings to discuss progress, past performance, future expectations, etc.

General and Administrative Overhead includes general supervisory labor, all administrative personnel, general and administrative material, contract support, station support which includes the station supply function, personnel support, the Industrial Relations Office, Data Processing, public works (facility maintenance) and utilities. [Ref. 8]

As can be read from exhibit #5, total labor and overhead amounted to \$22.16 per direct labor hour for NARF, North Island and this was the rate which the customer was billed for each direct labor hour applied during fiscal year 1977. Actual hours which were spent on each individual overhaul were billed, not a standard amount of hours per aircraft overhaul.

The rates quoted by Sikorsky Aircraft (see exhibit #6) are those proposed by Sikorsky for the one year period that they will be performing the depot level maintenance on the CH-53 while NARF, Pensacola is in the process of preparing their shops and tools to accommodate the overhauling of the aircraft and its major components. [Ref. 9]

Manufacturing Overhead for Sikorsky Aircraft includes heat, power, lights, taxes, all facilities, machinery, equipment costs, indirect labor and fringe benefits.



General and Administrative rates include support of operations, personnel, product support, management, accounting, and fringe benefits for this labor pool.

In addition to these costs, Sikorsky adds another 15% of the total for profit.

Thus, Sikorsky's cost per direct labor hour computes out to  $1.15(1.21(3.38 \times 6.38)) = \$30.00$ .

The Direct Material Cost of \$28,960.00 listed on exhibit #5 is considered a norm or average and should be approximately the same, indifferent as to whom (contractor versus organic) performs the work, and therefore, it will not be considered any further in this analysis.

EXHIBIT #6

1977 PROPOSED RATES FOR CH-53 OVERHAUL

BY

SIKORSKY AIRCRAFT

DIRECT LABOR	6.38 per direct labor hour
MANUFACTURING OVERHEAD	238% of DLH
GENERAL AND ADMINISTRATIVE OVERHEAD	21% of (DLH and MO)
PROFIT	15% of above Total

C. A COMPARISON OF CONTRACTOR VERSUS ORGANIC RATES FOR AIRCRAFT OVERHAUL

At first glance it seems apparent that the NARF is unquestionably the more cost effective way to perform depot level maintenance on the CH-53 (\$22.16 per direct labor hour versus \$30.00). However, several



factors are worthy of further consideration: (1) the cost of land and facilities is not included in the totals for NARF, nor is there any allowance for cost of capital invested in land and facilities, (2) Naval Air Rework Facilities are immune to most taxes, federal, state, county, city and property taxes, (3) the Navy Industrial Fund allowance for NARF is not charged as cost of capital and (4) any existing real or non-pecuniary benefits that may exist for either organization.

1. Cost of Land and Facilities

Completely accurate data on the cost or present value of land and facilities is not available for this paper. Such data would necessitate a complete appraisal by a competent real estate appraiser and the cost of such is beyond the realm and purpose of this paper. However, two sources of data were uncovered by the research in preparation for this writing. The first is a pamphlet published by the Naval Air Rework Facility, North Island on 1 October 1968. [Ref. 10]. The second is NARF's Financial and Cost Statements for the quarter ending June 30, 1977. [Ref. 11]. Some conflict exists which will try to be resolved at the conclusion of this heading.

- a. NARF pamphlet dated 1 October 1968. [Ref. 10].

The present value of land and facilities at NARF, North Island was estimated at \$42,300,000 as of the publishing of this pamphlet. Appreciating this figure at an annual rate of 10% (estimated 12% for land and 8% for industrial facilities by a qualified California realtor and appraiser) results in a current present value of \$100,920,016. This

figure was arrived at by multiplying the 1968 value of \$42,800,000 by a future value factor of 2.3579 (9 years at 10%). These facilities are utilized in the overhaul of many different types of aircraft and their components. Therefore, in order to qualify what percentage of the above mentioned land and facilities is devoted solely to the CH-53, some estimate of the ratio of CH-53 related work to total work is necessary.

One approach of arriving at this percentage is to take the weighted average of work performed in fiscal year 1977. NARF, North Island performed a total of \$93,000,000 worth of airframe related work and \$62,000,000 worth of components related work.<sup>4</sup> Of the airframe work, 7% was CH-53 related and of the component 32% was CH-53 related. Therefore, of the total work performed (\$155,000,000), \$26,350,000 was CH-53 related. This figure was obtained by adding 7% of \$93,000,000 (6,510,000) to 32% of \$62,000,000 (\$19,840,000). This total amount of CH-53 peculiar work represents 17% of the total work performed at NARF, North Island during fiscal year 1977 and it represents a reasonable average to use in this analysis.

However, because of the other minor work that is performed at NARF, North Island (calibration of equipage, incorporation of designed

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<sup>4</sup>This information was obtained by the telephone conversation with the Comptroller Division, NARF, North Island.

technical directives, etc.) their comptroller division estimates a more conservative percentage for analyzing the CH-53's share of their total work load. Using this more conservative figure of 16 2/3% of NARF's facilities employed in the overhaul of CH-53 and related work, the capital investment required to support this work is approximately \$16,820,002 (16 2/3% times \$100,920,016). It is assumed that these resources could easily be freed for alternative uses, such as private industry. This assumption is also necessary to support the life cycle cost concept of this paper, since by reviewing the CH-53 program, decisions involving future systems may be made with more accuracy. One of these future decisions may well be to establish another NARF or to utilize contractor support for a future aircraft system.

The average number of CH-53 type aircraft overhauled annually by NARF, North Island, has been forty-two. The current average for direct labor hours per aircraft per overhaul is 4450 hours.<sup>5</sup> Therefore, the average annual direct labor hours dedicated to the overhaul of the CH-53 is 144,900 hours.

Utilizing the Department of Defense standard cost of capital of 10%, the opportunity cost to the public sector is \$1,682,000 annually to support facilities for CH-53 overhaul. This figure was arrived at by multiplying the invested capital of \$16,820,002 by 10%

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<sup>5</sup> Ibid.



and rounding. Using the annual figure of 144,900 direct labor hours, the cost per direct labor hours for facilities is \$11.60 per hour ( $\$1,682,000 / 144,900$ ). Using this costing method for land and facilities, the \$11.60 per direct labor hour should be added to the \$22.16 per direct labor hour figure for NARF, yielding a new figure of \$33.73 per direct labor hour. This new figure exceeds Sikorsky's \$30.00 per direct labor hour and does not yet include the other factors mentioned above.

b. NARF's Financial and Cost Statements for the period ending June 30, 1977. [Ref. 11].

The method used in this analysis parallels the above analysis, therefore, repetitious matter is omitted.

According to NARF's Financial and Cost Statement for the period ending 30 June 1977, the amount of fixed capital invested for all overhaul activities was \$87,206,081. This figure was broken down into \$1,207,122 for land, \$37,904,882 for buildings, and \$48,121,422 for equipment. Depreciation allowance has not been deducted from the above figures because under the life cycle cost approach, the initial decision of organic versus contractor support requires that the full investment amount be considered. Also, depreciation is never a relevant cost in any cost effectiveness analysis. Another reason is that depreciation is considered a statistical cost and statistical costs are not charged to DOD customers. [Ref. 8, paragraph 4118.2].



Again, using the conservative figure of 16 2/3% for the CH-53's share of NARF's facilities, the capital investment required under this approach to the analysis is \$14,534,347 (16 2/3% of \$87,206,081). And as in the above analysis, it is assumed that these resources could be freed for alternative uses.

Using the Department of Defense standard cost of capital at 10%, under this method of analysis, the opportunity cost to the public sector is \$1,453,435 (10% of \$14,534,347 rounded) annually to support facilities for the CH-53 overhaul. Dividing this figure by the average annual figure of 144,900 direct labor hours yields a new cost per direct labor hour for facilities of \$10.03. When this figure is added to the \$22.16 per direct labor hour quoted by NARF, a new figure of \$32.19 is reached. This is lower than, although comparable to, \$33.76 which was the result of the above analysis but is still unfavorable when compared to Sikorsky's quoted rate of \$30.00 per direct labor hour.

Because of the a fortiori approach to analysis (worst casing the new (contractor) alternative and best casing the status quo (NARF) alternative), the lesser figure of \$32.19 will be used in any further analysis. Any evidence favoring contractor support will only be strengthened if the larger number were used.

It should also be pointed out that in the first comparison analysis, the cost of equipment was not considered in the organic support. This again, would only strengthen the argument.

## 2. Effect of Taxes on Contractor vs. Organic Support

In comparing two alternative ways of accomplishing the same tasks, any cost peculiar to one should be considered in analyzing both alternatives. In particular, taxes should be included in the analysis of contractor versus organic support for aircraft overhaul.

In 1976, Sikorsky paid a total of approximately \$16,000,000 in taxes.<sup>6</sup> No data exist on the breakdown of these taxes because Sikorsky is a division of United Technologies, and as such, does not publish its own financial statement. However, it is evident that the only duplication of taxes between the public and private sector is contribution to employees' retirement funds which, in the case of the private sector, is the employer's portion of social security taxes, and in the case of the public sector is the government's liability brought about by government employees' retirements. All other tax burdens are peculiar to the private sector, and should be considered in any analysis between sectors, since it is a cost of operation to the private sector, but not the public. When the federal government negotiates with a private sector firm to fulfill certain contracts, that firm must include taxes with their expenses. This results in a higher cost but in essence it means that the public sector is providing to the private sector firm additional income that will be returned to the public sector

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<sup>6</sup> This information was received by telephone conversation with Sikorsky Aircraft's Product Support Division. Their accounting division was unwilling to disclose a comprehensive breakdown.

in the form of taxes. In the case of organic support, this step does not take place.

Because of the lack of data, only the corporation income tax, both state and federal, will be analyzed. Referring to EXHIBIT #6, Sikorsky's funded rates, it is shown that they added 15% for profit. The State of Connecticut's corporation tax rate is 6.5% and that of the federal government is 48%. Any corporation state tax is deductible from adjusted gross income, similar to an expense, for the sake of determining federal income tax liability.

Throughout this analysis, marginal income is assumed, that is, any income earned by Sikorsky through the overhaul of the CH-53 aircraft would be in addition to the firm's already existing income, and as such will be additional profit and will be taxed at the full rate.

If \$100,000 in marginal income is considered and the state corporation rate of 6.5% is applied, a state tax liability of \$6500 results. This leaves \$93,500 which is taxed at the federal rate of 48% or \$44,880. The total tax liability on \$100,000 marginal income is then found to be \$51,380. or a 51.3% total tax liability. For the sake of simplicity and in conformance with the a fortiori approach, a total tax rate of 50% is used in this analysis.

Without this 50% tax liability, Sikorsky Aircraft would realize the same income if they added only a 7 1/2% figure for profit. Computing this out,  $1.075(1.2.(3.38 \times 6.38))$  a new rate of \$28.05 is found for



Sikorsky Aircraft. Instead of subtracting the difference between this and the old rate of \$30.00 from Sikorsky's rate and again comparing rates, it seems more logical to add this figure to the already adjusted NARF, North Island, rate. This will in essence add a tax liability to NARF's rate and make it more comparable with Sikorsky's.

Making this adjustment NARF's new rate is \$34.04 (\$1.95 + 32.19) which compares even more unfavorably with Sikorsky's \$30.00. Considering city and county taxes and property taxes would further strengthen the argument in favor of the contractor in the category of aircraft depot level maintenance and provides insight into future decisions concerning contractor vs. organic support.

### 3. Effect of Capitalization of the Navy Industrial Fund

As of 31 August 1977, the cash allocation for the working capital of the Navy Industrial Fund for the Naval Air Reworks Facility, North Island was \$13,700.00. [Ref. 12, EXHIBIT A-1]. This amount represents a permanent investment by the public sector in the overhaul of aircraft, but for which there is nothing earned. In order to conduct an equitable cost comparison, some opportunity cost should be included for this amount. A defense contractor uses his own funds to conduct operations and the cost of these funds is included in his per direct labor hour charge. Therefore, the cost of maintaining the Navy Industrial Fund at NARF should also be included in their rates. Department of Defense Directive 7041.3 of 18 October 1972 and SECNAVINST 7000.14B of 18 June 1975 states:



Interest will be treated as a cost which is related to all Government expenditures, regardless of whether there are revenues or income by way of special taxes for a project to be self-supporting. This policy is based on the premise that no public investment should be undertaken without explicitly considering the alternative uses of the funds which it absorbs or displaces.

a. One way for the Department of Defense to assume this is to adopt a discount rate policy which reflects private sector investment opportunities foregone. The discount rate reflects the preference for current and future money sacrifices that the public exhibits in non-Government transactions. A 10 percent rate is considered to be the most representative overall rate at this time.

Again, using this 10 percent rate, an additional burden of \$1,370,000 is borne by the public sector annually. This charge has no parallel when an analysis of contractor overhaul is considered. Therefore, in order to have a more accurate comparison of contractor versus organic support, some amount should be added to the NARF, North Island rates.

This added amount can be found by multiplying the CH-53's 16 2/3% by the annual additional sum of \$1,370,000 and dividing by average annual direct labor hours for CH-53 support ((16 2/3% X 1,370,000)/144900) which equals another \$1.58 for a total adjusted direct labor hour rate for NARF of \$35.62 (\$32.19 + \$1.95 + \$1.58).

#### D. CONCLUSIONS AND CONSIDERATIONS

##### 1. Effects of Newly Computed Rates on Life Cycle Cost

Using these two figures (Sikorsky Aircraft = \$30.00 per direct labor hour and Naval Air Rework Facility = \$35.62 per direct labor

# EXHIBIT #7

## COMPUTATION OF LIFE CYCLE COST OF DEPOT LEVEL MAINTENANCE FOR AIRCRAFT

### OVERHAUL OF THE CH-53

	ORGANIC	CONTRACTOR
COST/DLH	35.62	30.00
times hours/aircraft/overhaul	4450	4450
EQUALS	<u>158509</u>	<u>133500</u>
times aircraft/year	42	42
	<u>6,657,378</u>	<u>5,607,000</u>
Multiplied by the annuity	8.514	8.514
Factor for 20 years at 10%	<u>56,680,916</u>	<u>47,737,998</u>

DIFFERENCE (ORGANIC MINUS CONTRACTOR) + \$8,942,918.

hour) and considering the expected twenty year life of the CH-53, and additional life cycle cost of \$8,942,918 (EXHIBIT #7) is borne by the private sector when organic overhaul support is used instead of contractor support in the CH-53 aircraft system.

This cost is expressed in terms of the present value of difference in the life cycle cost in 1976 dollars since 1976 data (funded for FY77) was used in the analysis.

## 2. Other Factors With an Influencing Impact

In addition to this added expense to the public sector, other factors enter into the decision to utilize either contractor or organic support of aircraft systems. Most are difficult to quantify, in fact, most are not yet known. Two additional factors are mentioned below to provide areas for thought. The list is by no means complete.

### a. Permanent Location

It has been previously mentioned that an anticipated move of overhaul support for the CH-53 has given opportunity for a contractor versus organic cost comparison. This move is going to be very costly and would not be necessary under contractor support. Based on interviews with company executives, it is estimated that total cost to the U.S. Navy for this move will approximate \$2,000,000. This figure includes the cost of Sikorsky's preparation of tooling and equipment for the interim period and also the cost of shutting down the overhaul operations at NARF, North Island, moving the equipment to NARF



Pensacola and preparing that site for operation. And there is no reason to believe that this will be the last move or the last unnecessary tax burden on the private sector.

b. Aircraft Industry Business Fluctuations

A non-pecuniary benefit in contractor support would be a reduction in the large fluctuations of the business cycle in the aircraft industry. At Sikorsky Aircraft, these cycles have taken on ten year intervals over history and have had a devastating effect on their employment situation. Peaks at Sikorsky have been with 12,000 employees and valleys have been with 6,000 employees. This means that during every valley 6,000 trained employees are laid off and presumably pursue different careers. During each rise in the cycle, 6,000 new employees are hired and require training. This is an added unquantifiable expense and in addition, it requires time for these new employees to reach the efficiency of the old departed workers. This training and difference in efficiency represent costs which would not occur if contractors were utilized for depot level maintenance. This would have the effect of filling in the valleys, hence, reducing costs and increasing proficiency, and at the same time, would have the added pecuniary benefit of helping to stabilize local economies.

3. Summary

The advertised rate for direct labor hours presented by the Naval Air Rework Center, North Island indicates that the Navy is



utilizing the most economical source for aircraft overhaul in the CH-53 program. However, a direct comparison of these organic rates with proposed contractor rates is insufficient and inaccurate because the rates do not contain the same components.

As this chapter pointed out, the organic rates do not include cost of land and facilities. It is interesting to note that when dealing with non-federal government customers these costs are considered. Excerpts from the Navy Industrial Fund Handbook for Naval Air Rework Facilities reveal:

STATISTICAL COSTS---DEPRECIATION [Ref. 8, paragraph 4118.2].

a. GENERAL. Depreciation will be computed on buildings, structures and utilities, equipment and industrial plant equipment which was used either directly or indirectly in carrying out the productive mission of the activity. Depreciation expense will not be computed on items of plant property, the maintenance of which is financed by military support or mobilization reserve funds.

UNFUNDED COST [Ref. 8, paragraph 4117.8].

A. Definition. Unfunded (statistical) costs are defined as:

- (1) Depreciation on Plant Property
- (2) Military Pay and Allowances

b. Unfunded (Statistical) Rate. An unfunded (statistical) rate will be established annually for use in collecting unfunded costs applicable to non-federal government orders.

SCOPE (under Budgeting) [Ref. 8, paragraph 3102].

The Operating Budget will be based upon all data available in connection with the anticipated

workload. All operating costs will be financed by the Navy Industrial Fund revealing fund except the cost of Government furnished materials and certain statistical costs. Although not funded by NIF, Government Furnished material and military pay and allowances will be included as separate cost estimates in the production budget and the cost center overhead budgets.

These statistical costs which are charged to non-federal government employees contain not only an allowance for depreciation but also an allowance for military pay and allowance. They are truly a cost of doing business and should be included in any cost analysis for future decisions.

Not included in statistical cost are the opportunities foregone in the investment in land and in maintaining the Navy Industrial Fund. In reaching any accurate conclusions concerning real cost, these items must be considered. And, in any cost comparison between private and public sectors, taxes should also be considered as documented above.

The present methods of cost analysis within the federal government appear not to be peripheral, that is, they considered cost to only certain funds not total cost to the government, whereas any contracted cost with a defense contractor does represent total cost.

A Department of Defense directive adds an appropriate summation: [Ref. 14, paragraph IV, B].

.... the Department of Defense will depend upon both private and Government commercial or industrial sources for the provision of products and services, with the objective of meeting its military readiness requirements with maximum cost effectiveness ....

Military Readiness Requirements, as a function of organic or contractor support overhaul efficiency, would be the subject of another study. However, contractor support cost as computed in this study is clearly less than organic support, and even if equal effectiveness is assumed, the former is more cost effective.



#### IV. SUMMARY

##### A. APPROACH OF STUDY

It should be emphasized that the primary purpose of this study was not to change the existing CH-53 system but rather to provide information for planning future systems. All calculations included in this study are legitimate for future planning and the differences uncovered in costing between organic and contractor support should be considered in evaluating true planned costs of training and overhaul support. This study would have value to the CH-53 system only if that system were in the planning stages, either initial or for further capital investment.

It is also worthy to again note that the issuance of OMB Circular A-76 was subsequent to the introduction of the CH-53 to the operational forces.

##### B. TRAINING AND OVERHAUL REVIEWED

###### 1. Training

Two considerations are necessary in planning for the training of maintenance personnel, efficiency and effectiveness. This study compared annual cost of contractor versus organic training and found contractor support to be favorable by \$1,662,367 annually.<sup>7</sup> This

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<sup>7</sup>In accordance with DOD Directive 7041.3, a 10% discount rate was used to determine the annual cost to the private sector (opportunities foregone) of the initial capital investment.



result favors contractor support when efficiency of the training program is considered. The study also favors the contractor when effectiveness (how well the training prepares the maintenance personnel to perform their tasks) is considered but for more subjective reasons, for example, years of instructor experience, instructor preparedness, instructor continuity, and availability of current information to the training program.

## 2. Overhaul

The results found in the overhaul comparison were contingent upon the different costing methods used by the contractor versus organic support. Three major areas of consideration were uncovered, the cost of land and facilities, the effect of taxes, and the cost of maintaining the Navy Industrial Fund. These are all costs that must be absorbed by the contractor but are not reflected in any way in NARF North Island's funded rates. When they were considered, another \$13.46 per direct labor hour was found that should be added to NARF's rate in order to make a more accurate comparison.<sup>8</sup> It is felt that when this latter figure of \$13.46 is added to the funded rate of \$22.16, the result of \$35.62 more accurately reflects the true cost per direct labor hour that organic support costs the public sector.

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<sup>8</sup> Ibid.

### C. COST ACCOUNTING STANDARDS

It has already been shown that a disparity exists in NARF's billing system when Department of Defense customers are compared with non-DOD ones [Ref. 8, paragraph 4118.2, 4117.8 and 3102]. Another disparity exists in the regulations by which the contractor must abide but which do not apply to organic support. Specifically, Cost Accounting Standards Board Regulations, Part 414, under purpose, states:

§ 414.20 Purpose.

The purpose of this Cost Accounting Standard is to establish criteria for the measurement and allocation of the cost of capital committed to facilities as an element of contract cost. Consistent application of these criteria will improve cost measurement by providing for allocation of cost of contractor investment in facilities capital to negotiated contracts.

The standard continues under "Fundamental requirement"

§ 414.40 Fundamental requirement.

(a) A contractor's facilities capital shall be measured and allocated in accordance with the criteria set forth in this Standard. The allocated amount shall be used as a base to which a cost of money rate applied

(b) The cost of money rate shall be based on interest rates determined by the Secretary of the Treasury, pursuant to Pub. L. 92-41 (85 Stat. 97).

(c) The cost of capital committed to facilities shall be separately computed for each contract using facilities capital cost of money factors computed for each cost accounting period.

It is clear that the federal government considers the cost of capital and facilities in evaluating contract rates proposed by defense contractors.

Therefore, it is felt that it is quite equitable to consider the same costs when arriving at a final hourly cost per direct labor hour for organic support.

#### D. CONCLUSION

This study has shown that contractor support is a viable alternative in some areas of aircraft system maintenance. Not only can costs be reduced in certain areas but contractor training may pay dividends by increasing the effectiveness of the individual maintenance personnel. This could result in a decreased number of aircraft and spare parts necessary to support a squadron's mission, thereby further reducing costs to the public sector.

In all future aircraft systems, a complete cost analysis should be performed in order to identify those areas where contractor support is feasible. In one present aircraft system, (T-44) all support is supplied by the contractor, the only task which is performed by the U.S. Navy is the piloting of the aircraft.

Another benefit which can be derived from utilizing more contractor support, especially in the area of aircraft overhaul, is a reduction in the amount of aircraft industry extra capacity. According to a Joint DOD/OMB study, the best estimate of annual total costs to DOD of the current level of extra capacity in the aircraft industry is \$300-500 million. [Ref. 16, page 7]. Extra capacity is defined as the difference between what the industry has demonstrated recently it can produce



and what it is now producing. It is felt that the annual cost of this extra capacity could be reduced by awarding to the industry, contracts which have been shown to be economically feasible, in the area of aircraft overhaul.



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